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Teaching Statistics to Elementary Children: Using a Problem-Solving Approach to Enhance Learning

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TEACHING STATISTICS TO ELEMENTARY CHILDREN:
USING A PROBLEM-SOLVING APPROACH
TO ENHANCE LEARNING

By

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An Honors Project Submitted in Partial Fulfillment
of the Requirements for Honors

in

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Abstract

When teaching statistics (or data analysis) to elementary children, it is beneficial to use a problem-solving approach that incorporates meaningful tasks to enhance the students' learning. This was determined through a careful review of literature, observations of elementary teachers, and the creation and instruction of a data analysis unit. The unit required the students to collect data on heights, organize the data in charts, and display the data in line plots. In addition, the students analyzed the data to calculate the average and other measures of central tendency and to answer questions that arose through the implementation of the lessons. In conclusion, using a problem-solving approach to teach statistics (or any mathematics) to elementary children is highly recommended.

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I would like to take this opportunity to thank those who helped to make this project possible. I want to thank the teachers who allowed me to observe them and those teachers who allowed us to enter their classrooms to collect data. Many thanks are due to my cooperating teacher who helped me plan and implement a successful unit. I would also like to thank those fourth-grade students who participated in the said unit.

Thanks are in order for my advisor, Dr. Lisa Owen, who has been a significant part of this project from the moment it was first conceived. She has provided countless hours of assistance and guidance throughout these semesters. Lastly, I would like to express gratitude to my family and friends who were a support system for me; emotionally, physically, and financially. This project would not have been possible without the help and support from the above mentioned individuals.

Introduction

“What? Why do I need to know this?” How many students have asked these questions through the years? For students to learn mathematics they must be able to make sense of the mathematics being taught. In order to provide students with ways to make sense of the mathematics, teachers must plan problem-solving experiences that are relevant to the students' lives (NCTM, 2000). Because of my special interest in statistics and data analysis, I wanted to know how data analysis could be taught to students in ways that would keep them from asking, “Why do I need to know this?”

According to the National Council of Teachers of Mathematics (NCTM), data analysis instruction should enable students to

- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
- select and use appropriate statistical methods to analyze data;
- develop and evaluate inferences and predictions that are based on data;
- understand and apply basic concepts of probability.

“Young children will not develop statistical reasoning if it is not included in the curriculum. Work in data analysis and probability offers a natural way for students to connect mathematics with other school subjects and with everyday experiences” (NCTM, 2000, p. 48).

I wanted to envision the role data analysis and the teaching and learning of data analysis played in the elementary classroom and knew the first place to access information would be through the research of the NCTM.

My senior honors project began with the question, “What is data analysis for scholars and how does that compare with how teachers and students view data analysis?” As I began to answer this question through a review of literature the question evolved, “What does instruction that promotes students making sense of data analysis look like?” If my plan was to teach data

analysis using a problem-solving approach, I needed to ask, “What are some of the ways I can plan and teach lessons that provide relevance and opportunities for students' mathematical sense making?” I would need to learn more about using a problem-solving approach to teaching data analysis in ways that would be relevant and meaningful to students.

Review of Literature

The purpose of this project was to learn how to use a problem-solving approach (and provide meaningful tasks) to effectively teach data analysis. The first step was to look at the research. I explored methods of teaching using a problem solving approach and more specifically the methods involved in teaching data analysis. I also looked for strategies to make mathematics and data analysis more meaningful for elementary students.

Problem-Solving Approach

NCTM defines problem solving as “engaging in a task for which the solution method is not known in advance. In order to find a solution, students must draw on their knowledge, and through this process, they will often develop new mathematical understanding” (NCTM, 2000, p. 52).

“Students’ understanding of mathematics, their ability to use it, and to solve problems, and their confidence in, and disposition toward, mathematics are all shaped by the teaching they encounter in school” (NCTM, 2000, pp. 16-7). As a result, students require effective teachers that understand the math content they teach and can draw on that content knowledge while teaching. “They need to know and be committed to their students as learners of mathematics” (NCTM, 2000, p. 17). Effective teachers need to be mindful of the strategies they use. They also need to reflect, continually improve, review and enhance what they know.

In addition, effective teachers need to have multiple ways and representations to teach the mathematics content and be aware of the pros and cons of each way. It is not sufficient for a teacher to know only one way to multiply, as not all students learn the same way. Having numerous ways to present material to the students will provide them with better chances of

success. Providing multiple entry points is an important component in creating a good problem-solving classroom.

Providing multiple entry points to a problem also gives students many choices for ways to “get in” to the problem. This strategy for teaching helps to create an autonomous environment. “Students learn more and learn better when they can take control of their learning by defining their goals and monitoring their progress” (NCTM, 2000, p. 21). In order for this to be effective, the students must be presented with appropriate yet challenging tasks. This is made possible by the knowledge and experience of the effective teacher who is mindful of the experiences she is providing to students. This autonomous environment is born out of the notion of constructivism.

When students are given opportunities to think about, act on and talk about their thinking they are constructing new knowledge. “Integrated networks, or cognitive schema, are both the product of constructing knowledge and the tools with which additional new knowledge can be constructed” (Van de Walle, Karp, & Bay-Williams, 2010, p. 20). When students are learning, they constantly arrange and rearrange knowledge through the processes of assimilation and accommodation. It is the arranging and rearranging, or the students’ reflections of the experiences, which lead to their learning with understanding (Van de Walle, Karp, & Bay-Williams, 2010).

In constructing their own understanding, students are given opportunities to use their own strategies and solutions to solve problems instead of using the prescribed methods linked to the direct instruction approach. As students use their own strategies they are in the process of making sense of the mathematics. Their sense making helps them make meaning and prepares them to discuss their findings with their classmates. In a problem-based classroom, students take ownership of their ideas and are responsible for their learning. This means the teacher can step

back and become a facilitator who allows the students room to make their own discoveries.

When the time is right, the teacher can ask students to share different strategies as they talk about the different ways they solved problems. The teacher can support students' strategies and when necessary help clarify students' strategies. In addition, a problem-based classroom relies heavily on teachers to promote reflective thinkers to use writing as they reflect on their learning, (Van de Walle, Karp, & Bay-Williams, 2010).

Meaningful Tasks

“Good problems give students the chance to solidify and extend what they know and, when well chosen, can stimulate mathematics learning. With young children, most mathematical concepts can be introduced through problems that come from their worlds” (NCTM, 2000, p. 52). In other words, to effectively teach through problem solving, one must use real world problems and meaningful tasks. These problems or tasks need to be well chosen by the teacher (or students) and allow the students to apply what they know. Young children are fascinated with the world around them, so why not provide this as a means to engage them and connect to their prior knowledge?

The National Council of Teachers of Mathematics maintains that students who study current events and the news, in general, are more likely to improve their reading, vocabulary, math and social studies skills (NCTM, 2008) Using current events to engage students in real-world applications for mathematics can prompt their mathematical thinking and also promote their continued interest in current events. Using relevant information or asking the students specifically about themselves should engage them in the lesson, making it “interactive and more interesting” (NCTM, 2008). Many teacher materials provide "fun" and "engaging"

games/activities to use in elementary classrooms but students may not gain the same understanding of the topic as they might have if data of personal interest was introduced. Activities can be "fun" but if students do not make a strong connection to the mathematics and to their own understanding, they will not learn.

Learning without understanding has become an increasing concern. In today's world, data can be seen everywhere. Students need to understand data analysis in order to gain the needed skills required as adults. "In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options in shaping their futures" (NCTM, 2000, p. 5). Therefore, particular attention is needed for the student to not only learn about the idea, but also to develop a deep conceptual understanding. (NCTM, 2000, p. 4). The NCTM Principles and Standards were written to "reflect society's needs for mathematical literacy" (NCTM, 2000, p. xii). The students need to know the math, and be literate to go about daily life.

Teaching Data Analysis

One cannot go about his or her daily life without encountering data in one form or another. Data is at the grocery store, on the playground, in the workplace and the classroom. In the classroom, data can be the heights of students, their favorite colors, how many pets at home, or the number of books read. Data can be qualitative—objects and pictures, or it can be quantitative—numbers and statistics. It is also categorized as being nominal, ordinal, interval, and ratio. Data can be found in the media, read in newspapers and created daily for numerous reasons. This data is analyzed and interpreted to make informed decisions in today's ever-changing world. Without a solid understanding of data and data analysis, people become

misinformed or develop misconceptions. This is only one reason why students must obtain the skills used to analyze data in order to become informed and data literate adults. (NCTM, 2000). In order to obtain these valuable skills, their teachers must “know the ideas with which students often have difficulty and ways to help bridge common misunderstandings” (NCTM, 2000, p. 17).

Learning with understanding is imperative to create mathematical literacy. When a student is proficient in mathematics he or she has “the ability to use knowledge flexibly, applying what is learned in one setting appropriately in another” (NCTM, 2000, p. 20). Students must be able to transfer their knowledge and learning into other contexts. These other contexts involve the real world, and the setting in which the students will encounter when not in the classroom. When individuals can use their knowledge flexibly, they can appropriately solve new problems, problems that are created with rapid changes and increasing technology. It is important that people know how to use mathematics responsibly and correctly. This ease and flexibility of using mathematics can begin in elementary school with meaningful yet challenging tasks.

“Young children are naturally curious about their world...” and are continually asking questions that essentially provide instances to introduce the students to data analysis (NCTM, 2000, p. 49). These questions can be designed to match the students’ interests or other things that are relevant to their experiences. “Although young children are often most interested in their own piece of data on the graph... putting all the students’ information in one place draws attention to the *set* of data” (NCTM, 2000, pp. 49-50). This is one piece of evidence that underscores the importance of using meaningful tasks when teaching data analysis to students. These tasks can expand from the student and connect the class as a whole. After reading about the ways

elementary students make connections between mathematics and the world around them I was ready to get in the classroom.

Methods

Observation

During the spring and early summer semesters of 2010, I reviewed research and spent time in elementary classrooms. I observed the interactions between teachers and students during mathematics instruction. I wanted to see what instruction using a problem-solving approach looked like in an elementary classroom. Observation of these actions would help me as I considered ideas about how to plan and teach a unit of my own creation.

I chose to observe three teachers at an elementary school in Providence, Rhode Island, then chose one teacher to work with following the observations. In fifth grade, the students created a circle graph using given data about materials needed to make concrete mix. In a different task, students surveyed each other about their snack preferences and used the data to create another circle graph. When I compared the level of student engagement in each of these two tasks, the students seemed much more engaged in the second task, the task that looked at their own data, snack preferences. They knew where the data came from and knew that each tally represented one student. They appeared to be more comfortable when asking questions and participating.

In third grade, the students used fraction cards they created to make equivalent fractions. One student used two cards to show, $\frac{4}{8} = \frac{1}{2}$ while another student used four cards to show, $\frac{1}{2} + \frac{1}{3} + \frac{1}{6} = 1$. After creating multiple equivalent fractions using their cards, students were asked to share their equations and also write the equations on the board. This lesson provided the students with many problems with multiple entry points and multiple solutions which kept them very engaged. In another lesson, the students used pattern blocks to represent cookies and expand on their

understanding of equivalent fractions. The idea that pattern blocks represented cookies seemed to excite the children and also seemed to give them a purpose in the lesson.

In fourth grade, the students learned about multiplication and division. During one lesson, the students used multiplication to find the number of pencils needed in the class if each student were to receive 3 pencils. They also had to figure out how many boxes they would need if each box contained 20 pencils. The students solved the problem and saw there were leftover pencils. This lesson was effective because the students were given a worthwhile problem to solve, they knew the pencils were for their class and they could actually visualize what a remainder looked like. A remainder was no longer an abstract concept.

In all three classrooms, these three teachers provided their students with problems to solve and the students viewed this as a challenge. In all three grades, the teachers made connections to the students' interests (cookies and snacks) and incorporated lessons that helped students make connections to their own lives. At times, these connections were more subtle than others. The teachers moved throughout the classroom to observe the students working and to provide assistance and encouragement. The students worked together cooperatively and often answered questions for their classmates. Each lesson began with an introduction and directions, and ended with a closure or a time to share. The largest portion of time, in the middle, was given to the students to investigate and work on these problems using their own strategies.

The teachers questioned the students when they shared or provided a response. Questions included "Do you agree? Why might this not work? How else could you solve this? What's another way? What steps did you take to figure it out?" The students knew that finding an answer to the problem was only a portion of what was required. They also needed to explain their procedures and steps. When errors appeared, the class tackled them together and found out

what may have gone wrong. They worked as a class to find the proper solution or an alternate strategy. In fourth and fifth grade the students received homework and discussed it the following day. The homework presented the skills learned in class and gave the students an opportunity for additional practice.

After my observations and conversations with the teachers, I saw first-hand how important it was to present a lesson that focused on a student-centered problem. I was able to observe some lessons where the students could personally connect to the data and problems, because it was related to them. Whether the students worked independently, with a partner or small group, or as whole class they all worked as a cohesive unit to complete the task. The students helped their classmates when possible, and their explanations and reasoning benefited their peers. I knew that my lessons must incorporate all of these strategies for making connections in order to be successful. When considering how to plan a unit for instruction, I also had to consider what the classroom teachers did to prepare for and instruct lessons. The teachers provided the task (to engage students) and the environment (a space for students to explore and share).

Pre-Assessment and Instruction

After the observations I decided to teach my unit in the fourth-grade class because the students were an extremely energetic group who welcomed me into their classroom. I felt comfortable with the cooperating teacher, too who was hospitable and had an interest in working with me from the start. She was readily available to communicate and graciously allowed me to use her classroom to teach my unit. Our collaboration came naturally, and together we brainstormed ideas that would allow me to incorporate the data seamlessly into their

mathematics portion of the day. Together, we determined it was best to introduce the students to averaging, and I chose to approach it in a problem-solving manner.

I created a pre-assessment to gain background knowledge of the students in data analysis. The pre-assessment included three questions (see Appendix A for pre-assessment). The first question assessed students on their ability to read a line plot and identify the mode, median, and range. They were asked to define these three terms. The second question presented students with a set of data that required them to create a line plot to represent the data. The third question presented students with a bar graph and they were asked what the *average* student did, and why they thought this. It was hoped that this last question would provide insight into what the students already knew about averages or the mean.

Using the NCTM Data Analysis Standard as a guide, I wrote a three-lesson data unit. The focus of these lessons was for students to explore their heights and the heights of data, subjects unknown (mystery data). To gather data, the students measured their heights then collected class data. They organized this data into charts and displayed it in graphs. The students analyzed the data finding the average height of the class. The students made inferences about another class and drew conclusions about which grade the data was collected from.

The cooperating teacher observed each of the lessons in the unit. After each lesson, we met to confer. I talked about what I did and she talked about what she saw and made suggestions for improvement. After each conference, I made the necessary modifications to my unit. In addition, I looked at the student work, and used it to plan the final lesson. The assessment results provided constructive feedback about the project and myself as a teacher and a place to begin reflecting. I was able to reflect on the quality of the lessons, and how the lessons have helped me to answer my questions about data analysis.

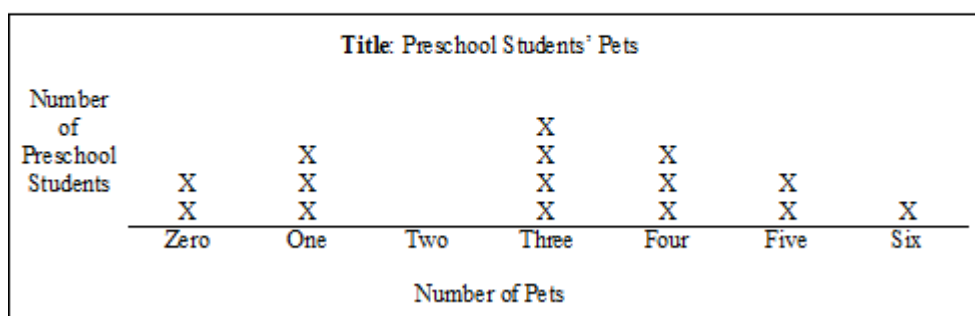
Analysis

Pre-Assessment

At the time of creating the pre-assessment (Appendix A), I knew I wanted the students to work with averages and use line plots and bar graphs to display their data. Using what I knew about problem solving and meaningful tasks, I tried to relate the pre-assessment questions and scenarios to their lives as elementary students. As a result, the questions were about pets, siblings, and television. This engagement piece hooked the students, all 19 of them, into the pre-assessment and provided a meaningful task right from the start.

Question one required the students to interpret a line plot and answer questions about mode, median, and range. I was able to observe the misconceptions that the students had about data.

This is a line plot.
Each X represents a preschool student. The two X's above zero mean two preschool students have zero pets.



Looking at the assessment results for the question “What is the mode of this line plot?” about half of the students left it blank. Two students rewrote the title, while six believed the mode represented the x-axis. One student said the mode represented a mound (shape of the graph), while another thought the mode was the total surveyed. When asked to “Define *mode*” nine of the students left it blank, while the remaining answers were varied. Two of the students believed mode was what you are counting, whereas four of the students define mode as what the

line plot is about. This evidence provides great information about the students' background knowledge—none of them understand the concept of mode. Therefore, I knew this was not something that I could use to engage the students, and I needed to introduce it to them during the lessons.

When asked “What is the median of this line plot?” eleven students left the question blank, while three believed it was the numbers on the plot or number of students. One student looked at the X's ranging from 0-4 and said that those with two X's (zero and five) were the median. Only two students correctly answered this question by identifying that 3 was the median. When asked to “Define *median*” an overwhelming fourteen students did not attempt to answer, while two responded with “numbers.” One student identified the median as the middle, while two others said it was the “center line of the graph,” and “the middles of the graph.” These results are evidence that the vast majority of the students in this fourth grade class do not understand what the median is. Thus the students require vocabulary instruction and examples of the middle number during my unit.

Results for the question “What is the range of this line plot?” were quite different; thirteen of the students correctly identified the range as 0-6, 6-0, or 6. Another student said it was “one number to another,” while one student thought the range was 7. The 7 came from the seven values of number of pets on the x-axis. When asked to “Define *range*”, eleven of the students were able to put range into their own terms including: “how far something is,” littlest to biggest, and smallest to largest, and where it starts and ends. Three of the students defined range as “how many there are,” but this did not fully define range, as it was not clear if the students were referring to the students or pets, or something entirely different. One student identified the range as “distance.” I recognized that the students had an understanding of range, but they would

benefit from a workable definition. Knowing that most of the students understood range helped me realize I could hook students with an activity that included background knowledge; they would be able to make connections to the activity because of the background knowledge they would bring to the lesson.

Question two required the students to take information in a chart and place the data onto a line plot.

Directions: Use this data set to make a line plot. Please add a title, and label the x-axis. Plot the data onto the line plot.

Third Graders' Siblings (Brothers and Sisters)	
Number of Siblings	Students in the Third Grade
Zero Siblings	1
One Sibling	4
Two Siblings	6
Three Siblings	4
Four or More Siblings	3

Title: _____

Students
in the
Third
Grade

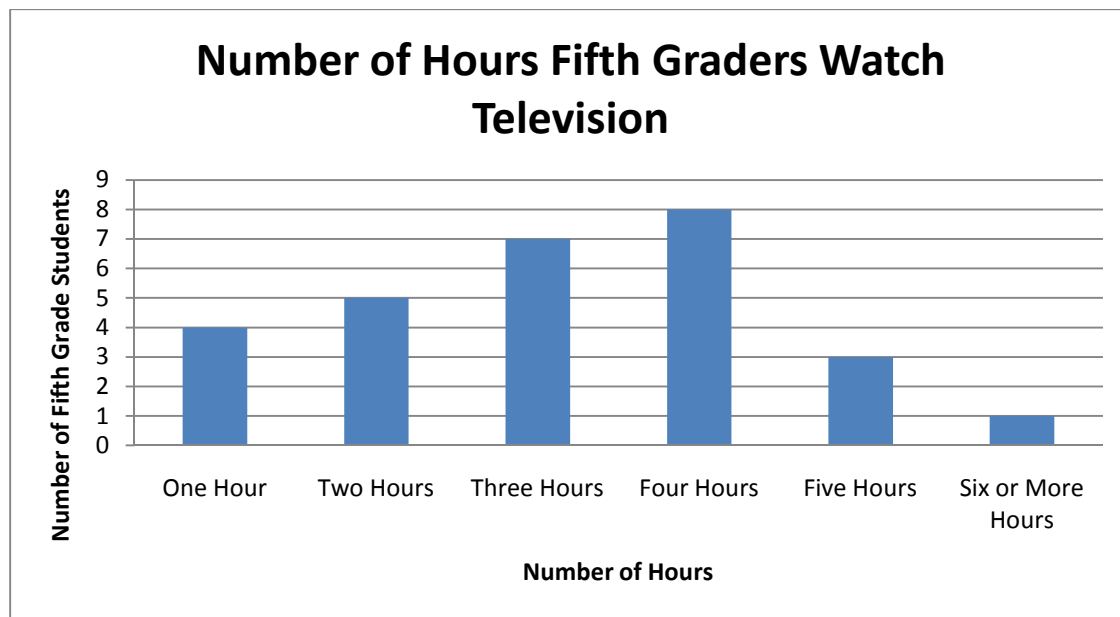
Zero One Two Three Four or More

Label: _____

Eighteen of the nineteen students were able to create a title that fit the information in the chart, while the other student left it blank. The students were asked to label the x-axis and fourteen of the students correctly labeled it as number of siblings or siblings. One student wrote “x-axis,” while four students left this blank. These responses are evidence that most of the students can use a chart to label the x-axis. Those students who had difficulty would benefit from the other students when creating graphs.

Seventeen of the fourth-grade students took the data from the chart and plotted it in the appropriate place on the line plot. One student originally had the X's, and then changed it to a bar graph, while another student randomly put the data on the line plot. This question provided evidence that the students can take information from an organized chart and create a table, and this shows that the students are capable of creating a graph or visual representation after the data is collected. A surprising finding from this question was the size of the X's in the line plot. Some of the students were careful to make each of their X's the same size, while other pre-assessments had different size X's within the line plot. I became aware that this was a skill that the students must learn about graphs. Graphs should be accurate and anyone looking at a graph should be able to easily read it and interpret it.

The last question presented the students with a bar graph and asked them about how much television the average student watches.



“How many hours does the *average* fifth grader watch television?” was the question the fourth-grade students were asked to answer. The average student watched three hours of television and only one student responded correctly to the question. Seven of the students answered two

because that bar was half way between the tallest and shortest bar. Six of the students believed four hours (the tallest bar) was the average number of hours. Three students identified one or 1-2 as the average amount, while one student said $3\frac{1}{2}$ hours was correct. Some of the students answered why they thought this with personal responses such as their sister watches x amount of hours of television, or as you get older you gain more independence (see Appendix B for student responses). It is interesting to note that most of the students did not look for the average number of hours, but rather looked at the number of fifth grade students and then found which bar was approximately in the middle.

This question hinted at average, and asked the students “Why do you think that?” I was able to see how the students think about the average and where as a class they may have some confusion. Some believed the tallest bar or the most number of students was the average, while others used the y-axis to find their answer. The students were careful in responding to this question, and had great ideas about how to find the average. The students all attempted this problem, because they have heard the word “average” before, and have used it in other contexts. The students have a basic understanding of the average, but need assistance in finding it. My lessons will provide the students with this help.

Planning and Instruction

After corresponding with the cooperating teacher, we determined that I would teach a three-lesson unit over three days. In my initial planning, my first lesson would introduce the students to statistics with a brief introduction. The students would also make predictions, collect data by measuring their heights and graph this data on a line plot. The students would calculate the average by finding the average in their four-person group and then use those averages to find

the class average. Lastly, arithmetic mean would be defined and we would discuss the difference between samples and populations. My second lesson would provide the students with mystery data (data from another class) and the students would compare the two classes. They would state how much taller a typical or *average* fourth grader is, what grade this data came from, and why they believe that. We would then learn about the vocabulary from the pre-assessment and create a line plot. In the last lesson, I planned to have the students create a survey at their table, and each student would ask other groups a survey question. Then, the students would find the average for the table and the class. They would graph their results, and state what they now know about a typical fourth-grade student.

After examining the pre-assessment data and considering students' misconceptions of graphs and vocabulary, I decided to remove individual graphs from the first lesson. This would provide the class with additional time to more deeply explore ways of finding averages and become more comfortable and knowledgeable of the vocabulary. We used the data and made a class line plot that would be referred to in the second lesson. After finding the average and discussing samples versus population, we defined measures of central tendency and outliers (see Appendix C for lesson plan 1). Originally, I planned an extension worksheet (see Appendix C for extension 1), but the students were highly engaged in the lesson, that the worksheet was given as homework. This was a way for the students to practice what they learned during the lesson, and be prepared for the next lesson.

The implementation of the first lesson went smoothly. The students were engaged throughout and enjoyed measuring their classmates. It was more manageable to have students find the average in their small group of four than to have them find the average of nineteen students. The small-group work also gave them opportunities talk to each other, share their ideas

and continue to develop their understanding and make sense of what it means to find an average. The students experimented with finding information on the average height by trying to find the number in the middle, or adding a few inches to one student and subtracting a few inches from another student so they would all be equal. Together, we discussed a workable procedure for finding the average. The students understood that when you had two numbers, the average was the number in the middle (in between), but when there are four numbers, the “middle” may not be the average. The students were already adding the two numbers and dividing by two when finding the average for two numbers. With a quick explanation of what they were already doing (without being aware of it), the students saw how they could calculate the average for the three or four members in their group. Once our data was collected, organized, and displayed we analyzed it further. The students used the average height to discover the average student in the class. Together, we looked at clusters and how the tallest student skewed the average slightly. I witnessed how much could be discussed and analyzed after collecting and organizing the data.

After teaching the lesson, I met with the cooperating teacher to discuss what she observed. Some of her suggestions were about ways to improve my teaching such as speak louder and slower, write with pen or marker at the document camera (not pencil), and circulate throughout the room. Other suggestions included what worked and did not work in the lesson. She suggested that all students must be doing something, even when working in small groups, whether each student has his own materials to use or a separate task to complete. Since the extension from lesson one was provided as homework, she suggested making time to go over the homework in lesson two. I agreed with all of her suggestions from the observations and made changes to the second lesson.

To begin lesson two we checked the homework and talked about the answers. This acted as an introduction to the lesson. In addition, we reviewed measures of central tendency, because the discussion was not as lengthy as I would have preferred. We used the line plot that we created the previous day to review the students' understanding of mean, median, and mode. Each student had a calculator and paper allowing them to do the math required in finding the average. They took turns writing on the recording sheet and together the group created a line plot. To end the lesson, the students shared their individual line plots and discuss their interpretations of the data (see Appendix D for lesson 2).

While teaching the lesson, each of the five groups correctly found the mean (average) of the data (49 inches). This was the evidence that students knew how to find the mean for a large group of numbers. Looking at only the mean was enough to determine where the data came from, therefore each group made a line plot. I provided the students with graph paper to complete their graphs, because they could use the small boxes to correctly space the graph and the X's. What troubled the students was how to mark intervals that measured $\frac{1}{2}$ inch on the line plot and then properly space the values on the x-axis. One group decided to include the $\frac{1}{2}$ inches on their x-axis (see Appendix E for student work) while another student suggested spacing the x-axis further apart leaving two boxes for each whole inch. Some of the groups opted to produce more than one graph or create a rough draft first (see Appendix E for student work). I noticed that many of the graphs lacked labels and titles. I noticed that group 4 used the individual heights to label the x-axis (39, then 46, 47, 48, 48.5 and so on. When I approached this group, we discussed their graph and I asked, "What if we measured a student that is 42 inches, where would that information go on the graph?" We looked at the line plot from the previous day and discussed

the appropriate spacing. This group recreated their line plot, and it was easy to see that 39 inches was an outlier (see Appendix E for student work).

After creating the line plots, the students shared their group's line plots and also shared from which grade level they collected their data. The discussion turned into a lively debate and the students were asking numerous questions of one another so they could explain their reasoning. One memorable question I heard, "How much does a student grow from third grade to fourth?" In other words, how many inches different would an average student from each of these grades be? The students were using what they knew about themselves, friends in other grades, and family members to help answer this question. The students used the knowledge they had about the fourth grade data and knew it came from a younger grade. After seeing the excitement and natural curiosity in these students, I knew tomorrow's lesson had to incorporate the mystery data (see Appendix F for lesson 3).

I briefly spoke with the cooperating teacher to discuss ideas for the next day. We decided that the students needed to collect more data, so they could be more confident in choosing the grade level behind the mystery data. "The main purpose of collecting data is to answer questions when the answers are not immediately obvious" (NCTM, 2000, p. 109). The answer to which class the mystery data was collected from was not apparent, thus collecting additional data on heights was needed. If we had data from more grades, we could compare that data to ours and the mystery data and say with better certainty what grade the mystery data was collected from. We informed the students what we would do tomorrow, and how we would need their help. Each group of students would go to a separate grade to gather data on the class and calculate the average height in each grade. The students were eager and willing to help solve this problem. Their eagerness would be a strong motivator for their next phase of the task. The task also

seemed to nicely align with NCTM's definition of problem solving, which promotes the engagement in tasks that have no immediately known solution (NCTM, 2000).

The cooperating teacher and I discussed the logistics of this task. We needed teacher permission from the other grades to collect this data, and needed it done as quickly and efficiently as possible. Instead of using individual measuring tapes, the idea arose for using a growth chart. I obtained a growth chart from the school nurse and made copies for the students. They taped copies of the growth charts together and carried them to the classrooms, visiting all grade levels between kindergarten and grade five. To increase efficiency, I made different items that would aid in the students' completing the third lesson. As a result, I created a data collection sheet for students to record their measurements. While measuring each student had a specific job; one student measured the heights, while a second student checked the height measured, a third student recorded the data, and a fourth student made sure the students were standing straight up against the growth chart.

The data collection sheets and measurement jobs were a success. The students were thrilled to have jobs and visit classrooms to find a solution to the problem. Since each group visited a different grade level, there was a wealth of data from grades K through 5. These data collection sheets and measurement jobs allowed for accuracy and efficiency which, in turn, prompted high engagement in the lesson. When the students returned to the classroom, the group looked at the individual data and made a prediction about the average height of a student in that particular grade.. Each group received a sheet of instructions to guide them. This was necessary, because different groups were entering and leaving the classroom at different times. Each student received a sheet to calculate the mean, median, mode, and outliers for their grade. Then, the

students worked in their small groups to produce a large line plot (see Appendix G for student work samples).

The students presented their line plots and their findings to the class. While presenting, it was decided that we would record the average of each grade on a growth chart in the classroom. This way the students could visually see the difference, which could better help them identify the mystery data. Once each of the groups presented, we used our newly collected information to make determinations about the mystery data. We also compared the growth between grades and discussed where growth spurts may occur, or what else could skew the data (more males than females, or vice versa). We compared the two fourth grades together to discuss what we observed. One student made a statement the previous day about being the size of an average third grade, so we compared her height to the average third grade height.

This third lesson was extremely successful because the students were involved from start to finish. It was highly engaging and the students took control of their own learning. They were responsible for taking the measurements and proudly shared their graphs. Allowing the students to go into other classrooms furthered the engagement and made the problem that they were solving more meaningful. Since the question arose from the students' curiosity, it was a problem that the students wanted to solve, and could solve. NCTM suggests that "...students should pose questions about themselves and their environment, issues in their school or other community, and content they are studying in different subject matters" (NCTM, 2000, p. 177). The students were successful in asking questions about themselves and their fellow classmates at their school.

Conclusions

The topic of my honors project revolved around teaching data analysis (statistics) through problem solving using meaningful experiences. In working on this project, I learned that young children are interested in exploring their world, examining the data in their life and then analyzing the data. For example, students are not only interested in how many pets they have, but also in who has the most pets or the same number or kind of pets. I have learned that the meaningful tasks do not require data solely about the child but it can also be about the classroom, school, or local community. Problem solving with authentic and relevant experiences encourages students to make sense of data analysis and the world around them. If students are personally connected to the math they are learning, they will better understand it. When students are directly connected to the curriculum, they are more likely to be engaged in the learning process. “Good problem solvers tend naturally to analyze situations carefully in mathematical terms and to pose problems based on situations they see” (NCTM, 2000, p. 53). I believe teaching data analysis through problem solving using authentic and relevant experiences more thoroughly develops students’ conceptual understanding as well as the significance of data analysis.

After completing the research, I have used what I learned about meaningful tasks and problem solving to effectively teach all areas of mathematics (not just data analysis) in my student-teaching experiences. I saw a need to provide the students with unique challenging problems that the students wanted to solve. “It is precisely through the experience of solving challenging problems that students grow in their mathematical understanding” (Reys, Lindquist, Lambdin, & Smith, 2009, p. 111). In addition to solving challenging problems, it is imperative that the students take control of their learning. “When children are told things, rather than figuring things out for themselves, they are less likely to remember them or to be able to apply

the ideas in the future” (Reys, Lindquist, Lambdin, & Smith, 2009, p. 111). This advocates constructivism and allows the students to take charge and be in control of their learning. When they do this they will have better mathematical understanding and will be better informed citizens.

After I graduate from Rhode Island College, I plan to teach elementary school or middle school mathematics. I want to be able to effectively teach data analysis to my future students. NCTM recommends that students should be able to “formulate questions that can be addressed with data, and collect, organize, and display relevant data to answer them, select and use appropriate statistical methods to analyze data, develop and evaluate inferences and predictions that are based on data, and understand and apply basic concepts of data,” (NCTM, 2000, p. 48). I have become comfortable with the Data Analysis and Probability Standard and I want my future students to have the same confidence I do. This project has provided the knowledge and experience needed to effectively teach data analysis.

This project has also provided me with strategies to help students use problem-solving skills to more thoroughly develop their understanding of the relevance and significance of data analysis. I will use what I have learned to educate myself as a professional and to prevent my future students from asking the infamous question of “Why are we learning this?” And if they do ask “Why?” as I always did throughout my schooling, I will have the appropriate and necessary answers.

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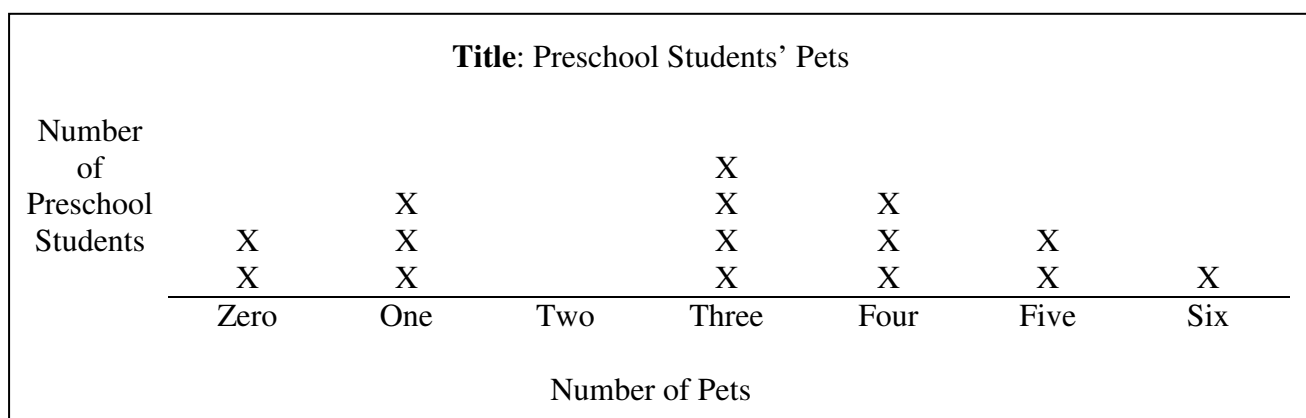
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Appendix A: Pre-Assessment

Name: _____

Date: _____

Directions: Please do the best you can to answer each question.This is a line plot.Each **X** represents a preschool student. The two X's above zero mean two preschool students have zero pets.

- What is the mode of this line plot? _____
- Define *mode*: _____

- What is the median of this line plot? _____
- Define *median*: _____

- What is the range of this line plot? _____
- Define *range*: _____

More on the back ☺

Directions: Use this data set to make a line plot. Please add a title, and label the x-axis. Plot the data onto the line plot.

Third Graders' Siblings (Brothers and Sisters)

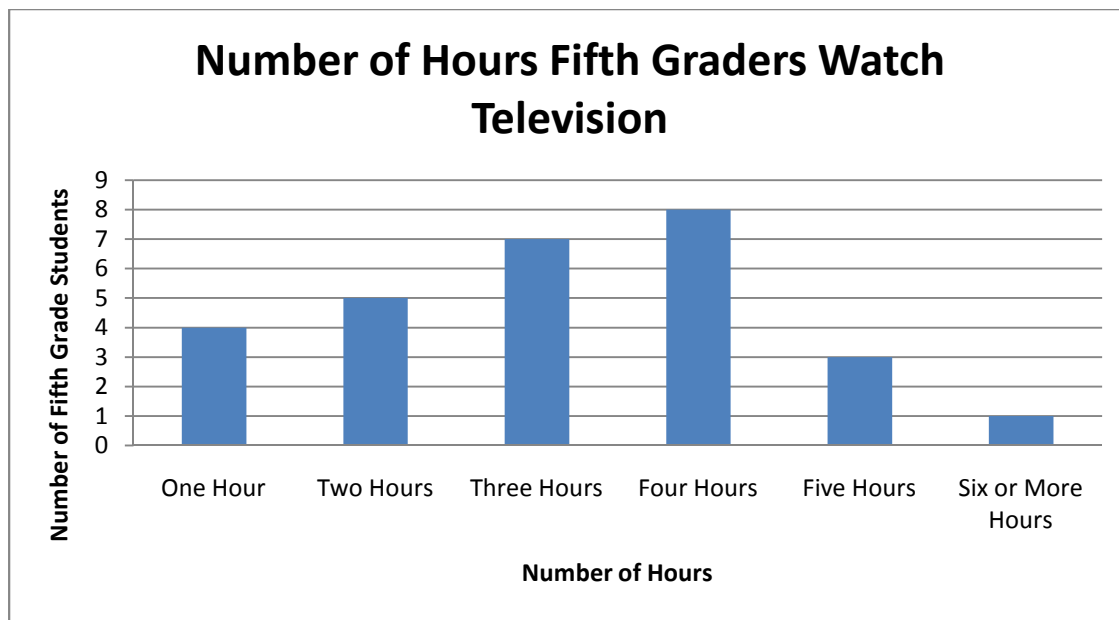
Number of Siblings	Students in the Third Grade
Zero Siblings	1
One Sibling	4
Two Siblings	6
Three Siblings	4
Four or More Siblings	3

Title: _____

Students
in the
Third
Grade

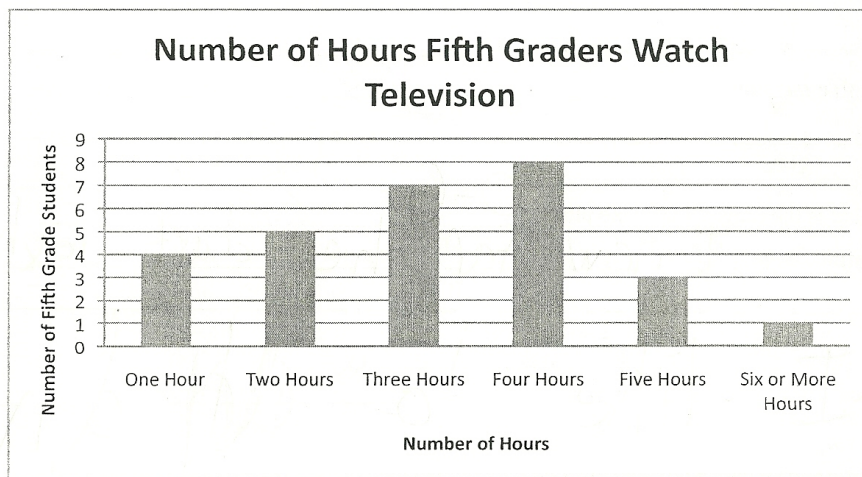
Zero One Two Three Four or More

Label: _____

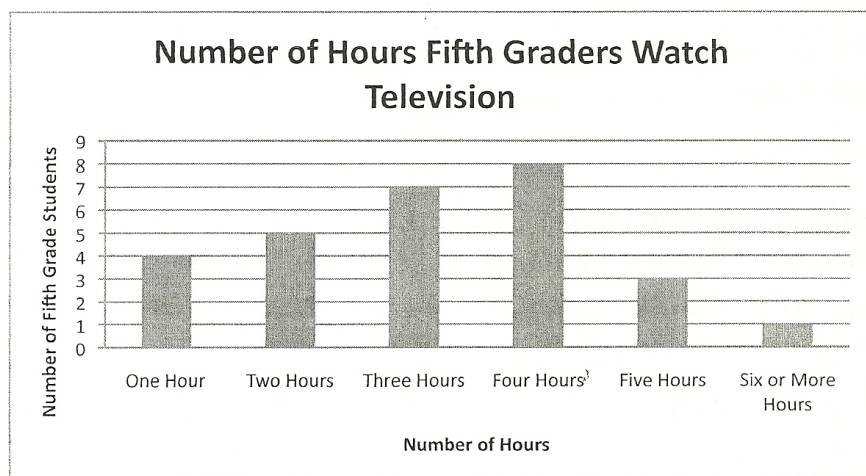


- How many hours does the *average* fifth grader watch television? _____
 - Why do you think that? _____
- _____

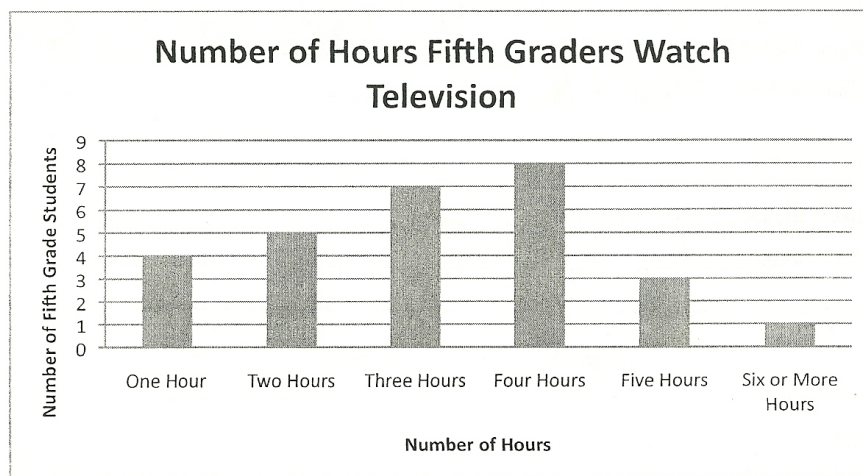
Appendix B: Pre-Assessment Results



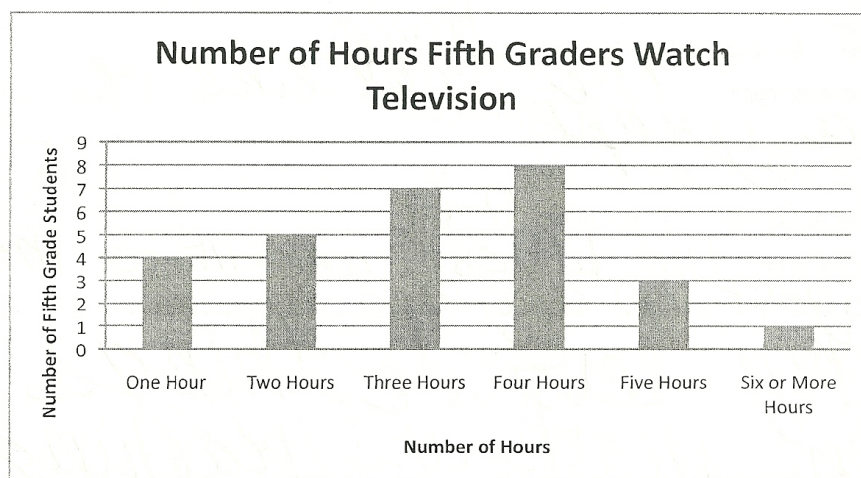
- How many hours does the *average* fifth grader watch television? 4 hours
- Why do you think that? Because most of the fifth graders watch 4 hours



- How many hours does the *average* fifth grader watch television? 2 hours
- Why do you think that? because the highest is 9
and 5 is almost half of 9 which is 2 hours.



- How many hours does the *average* fifth grader watch television? 4 hours
- Why do you think that? I think that because it is the tallest bar

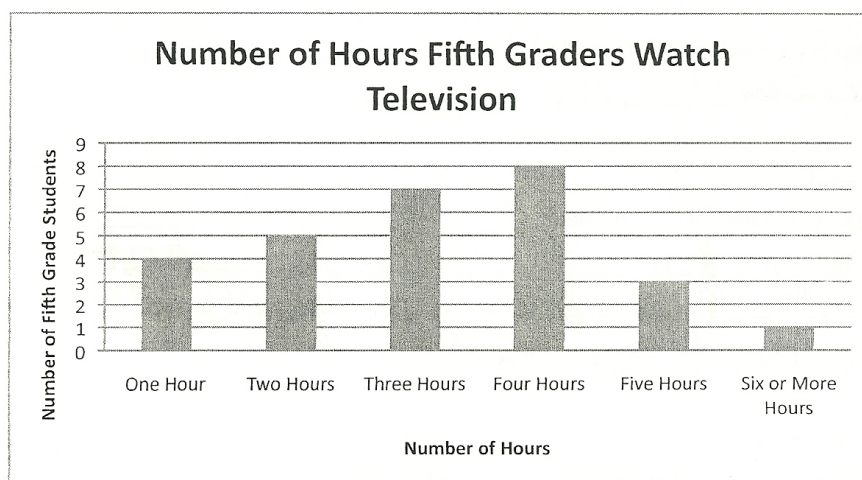


- How many hours does the *average* fifth grader watch television?

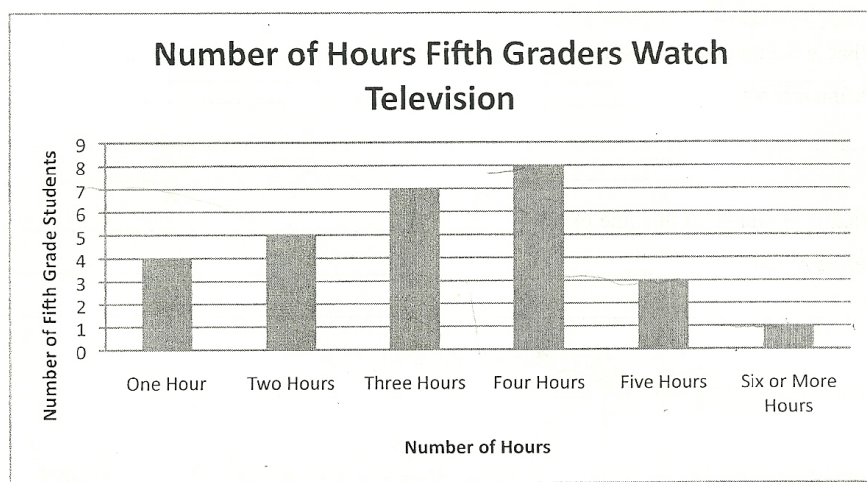
4 hours

- Why do you think that?

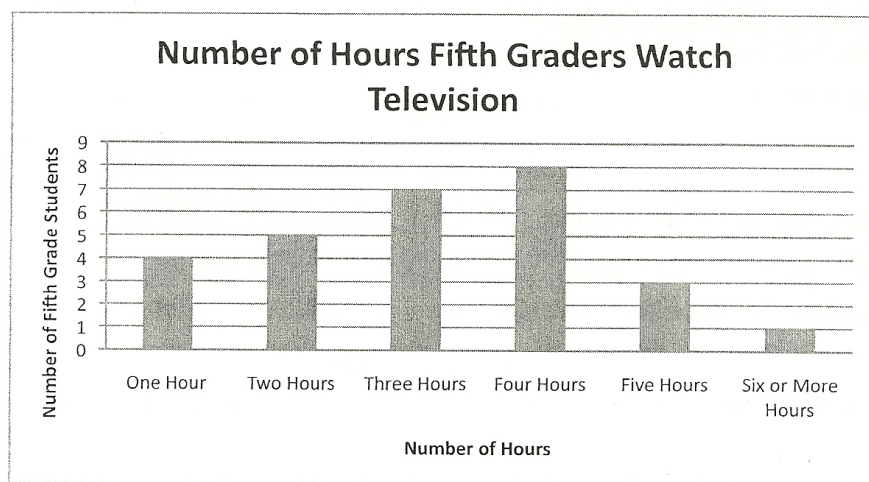
because as you grow older you get more independent



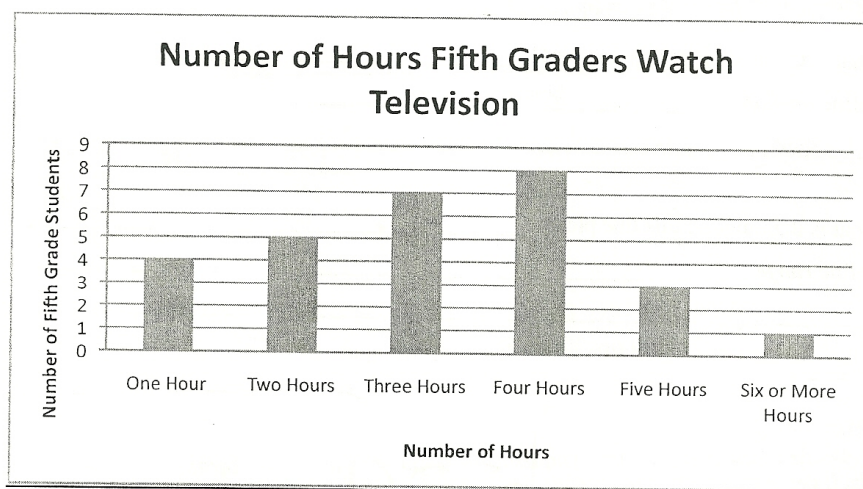
- How many hours does the *average* fifth grader watch television? 0-6 or more
- Why do you think that? I think that because that's what it says on the plot.



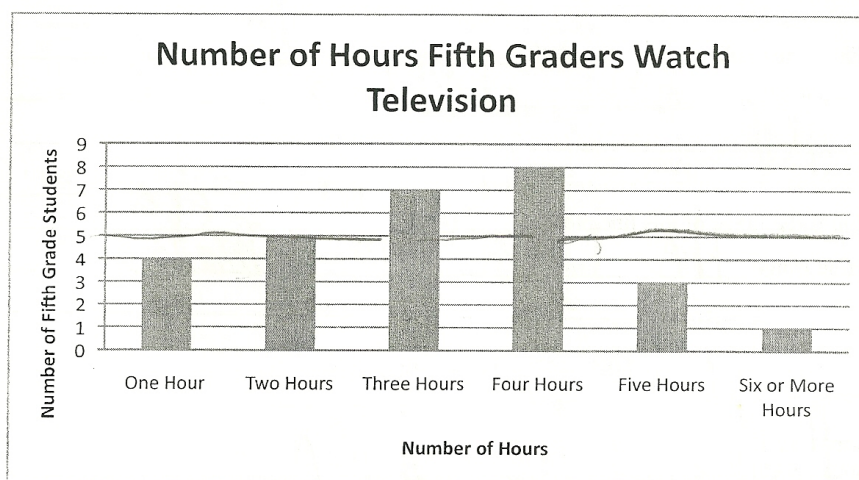
- How many hours does the *average* fifth grader watch television? 3 1/2 hours
- Why do you think that? because the



- How many hours does the *average* fifth grader watch television? one hour
- Why do you think that? I think that because my sister only watches one hour at the most.



- How many hours does the *average* fifth grader watch television? 1 hour
- Why do you think that? Because that's an average
amount of time.

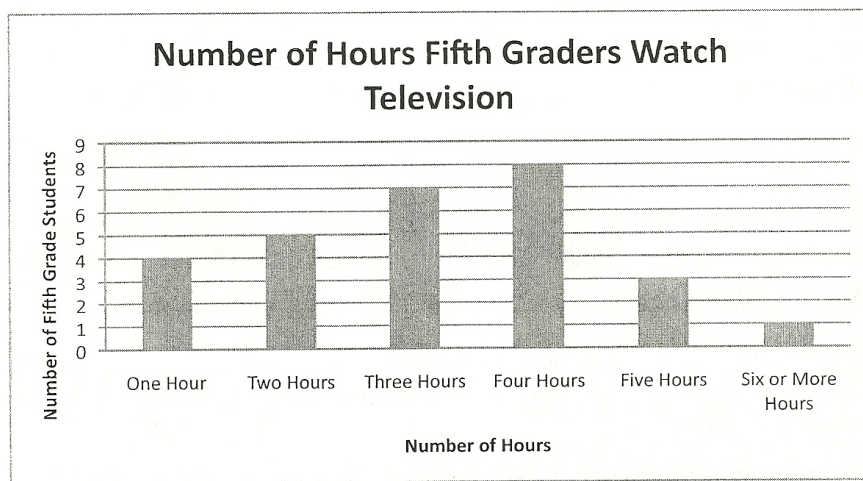


- How many hours does the *average* fifth grader watch television?

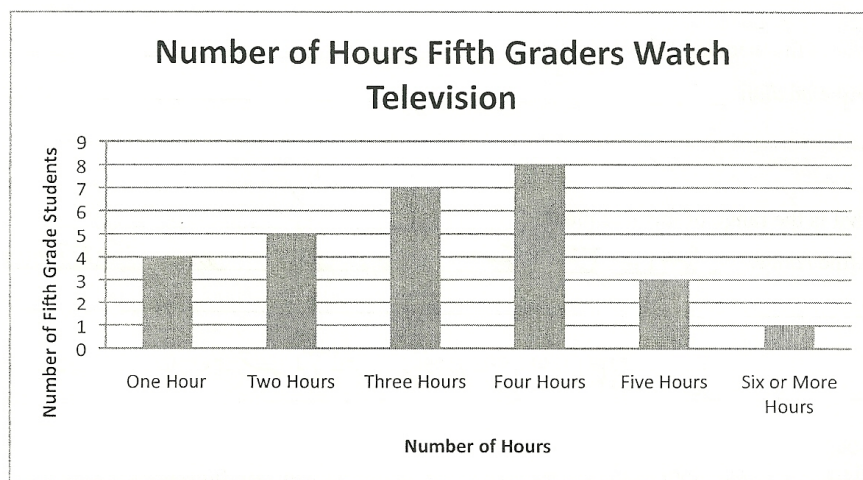
2 hours 35 minutes

- Why do you think that?

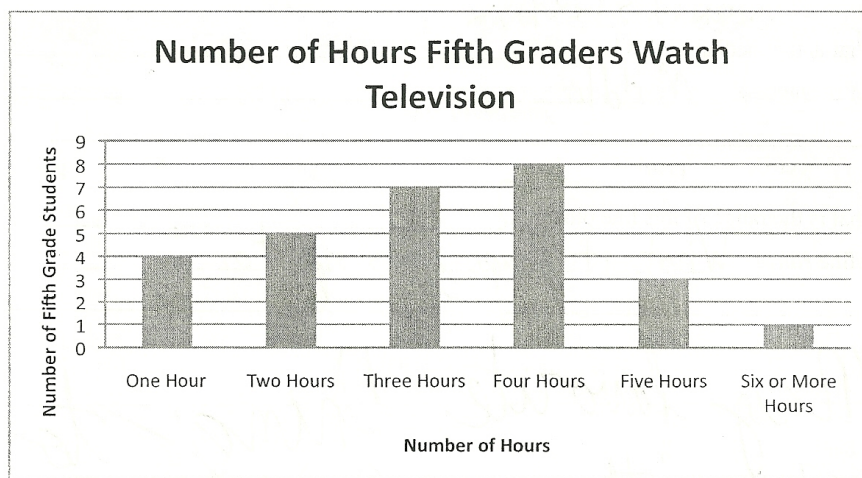
~~because the biggest bar is one~~
~~no people and the biggest is one~~
 because it is in the center of the bars



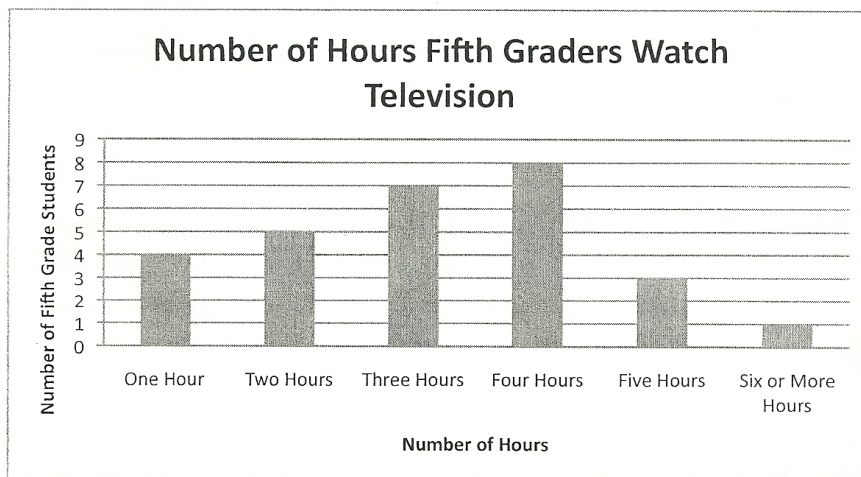
- How many hours does the *average* fifth grader watch television? 4 hours.
- Why do you think that? Because more 5th graders watch 4 hours of TV



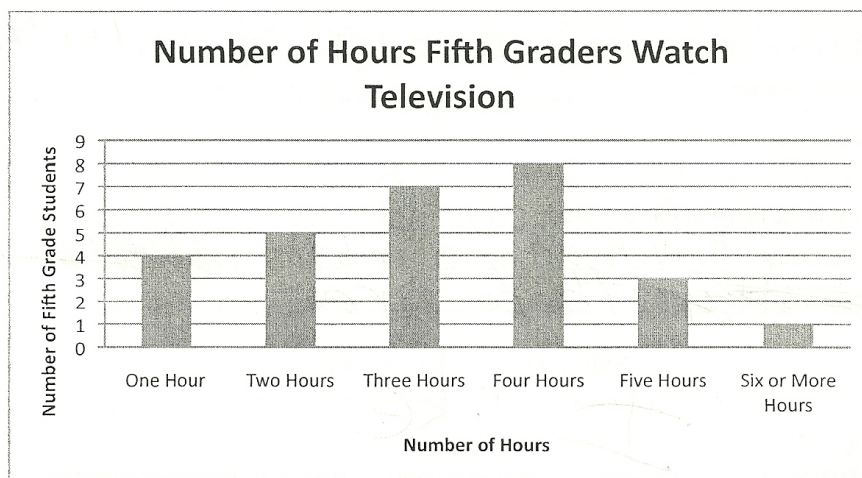
- How many hours does the *average* fifth grader watch television? 2 hours.
- Why do you think that? it is in between the highest and the lowest.



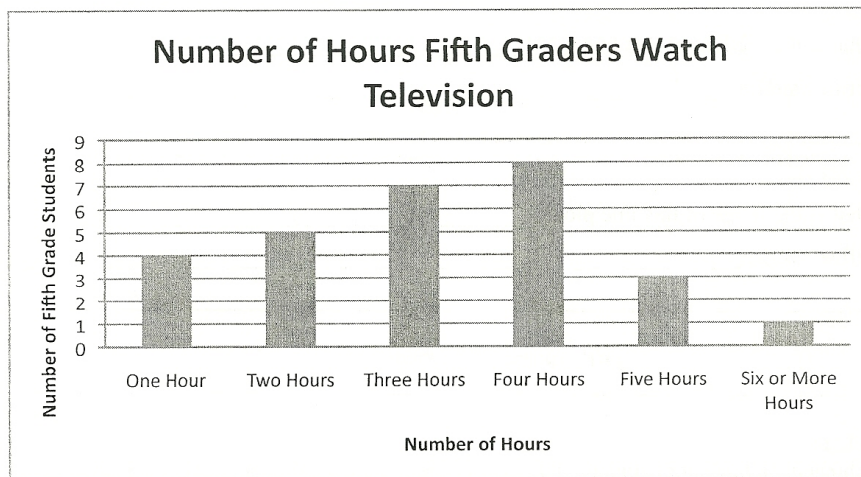
- How many hours does the *average* fifth grader watch television? 2 hours
- Why do you think that? because most people watch TV 2 hours



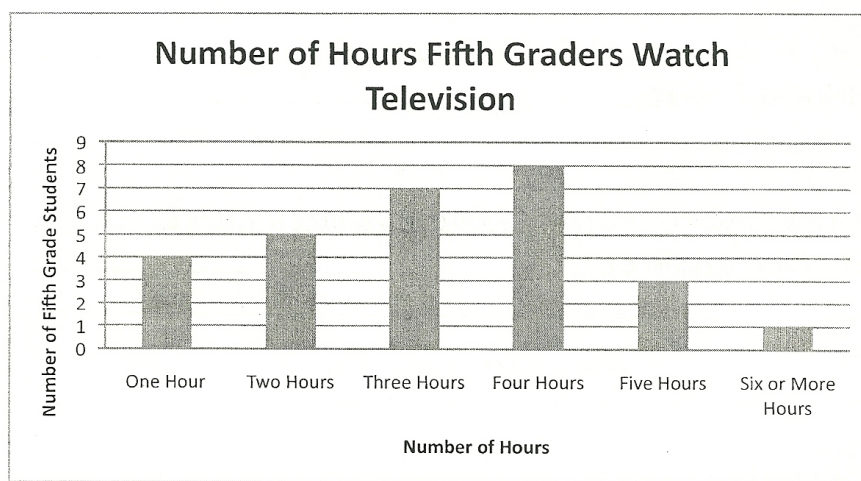
- How many hours does the *average* fifth grader watch television? three hours
- Why do you think that? I think that because
it = 15



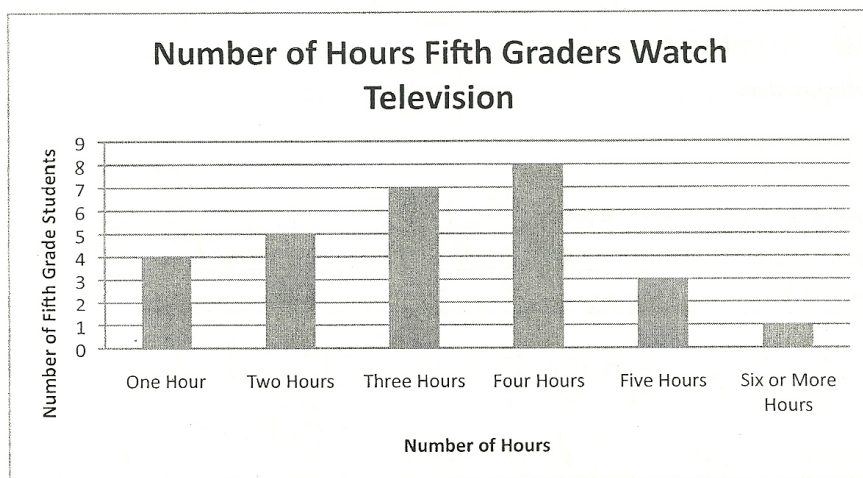
- How many hours does the *average* fifth grader watch television? 2 hours
- Why do you think that? because I usually watch 2 hours of TV



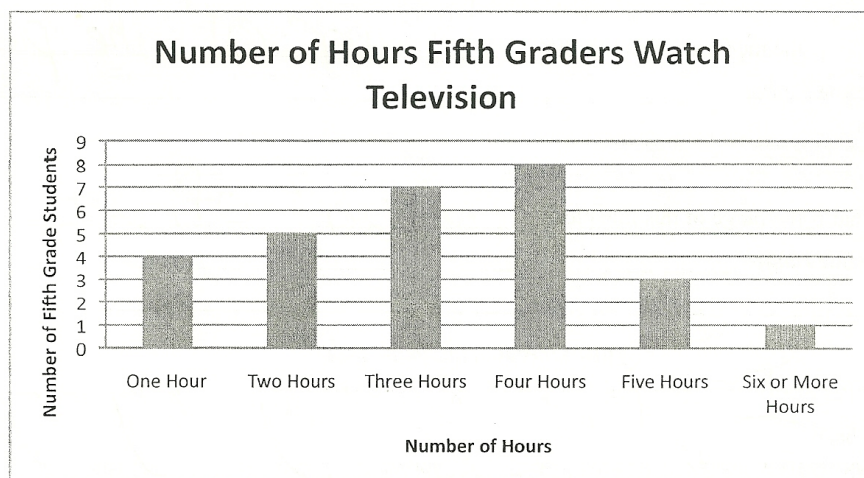
- How many hours does the *average* fifth grader watch television? 4 hours
- Why do you think that? I think that because eight fifth graders watch television.



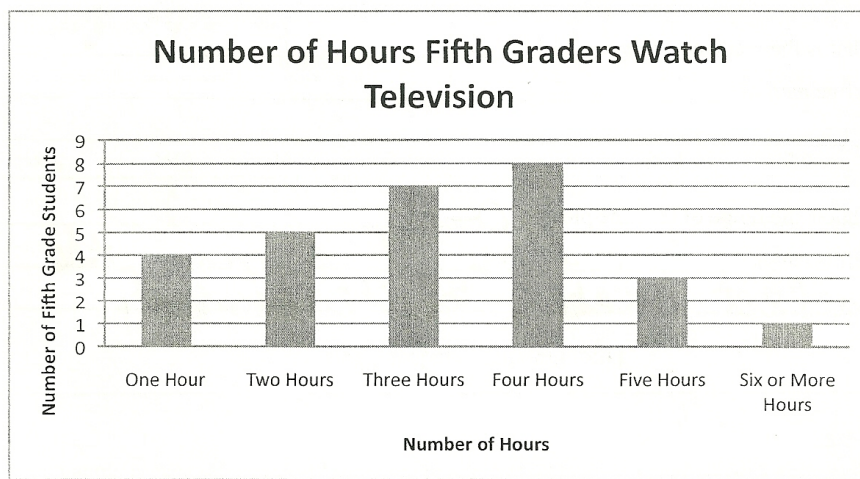
- How many hours does the *average* fifth grader watch television? 4.00
- Why do you think that? because it's a little low and high



- How many hours does the *average* fifth grader watch television? Two hours
- Why do you think that? I is about in the middle of number of students



- How many hours does the *average* fifth grader watch television? Four hours
- Why do you think that? Because that is the one they voted for the most



- How many hours does the *average* fifth grader watch television? 1-2
- Why do you think that? People watch alot of television these days,

Appendix C: Lesson 1 and Materials

Name Kayla Botelho
Date Monday, May 24, 2010

Lesson # 1
Grade Level 4

<p>Teacher materials</p> <p>Paper and pen for projector</p> <p>Prediction Sheet</p> <p>Graph Paper for Line Plot</p>	<p>Student materials</p> <p>Measuring tape, rulers</p> <p>Pencils, paper</p> <p>Calculator</p> <p>Recording Sheet</p> <p>Worksheet for extension</p>
<p>Objectives/outcomes</p> <p>Students will be able to:</p> <p>measure heights in inches to the nearest $\frac{1}{2}$ inch</p> <p>find the average height in their class.</p> <p>find the arithmetic mean of their heights.</p> <p>M(N&O)–4–4 Accurately solves problems involving multiple operations on whole numbers or the use of the properties of factors and multiples; and addition or subtraction of <u>decimals and positive proper fractions with like denominators</u>. (<u>Multiplication limited to 2 digits by 2 digits, and division limited to 1 digit divisors.</u>) (State)</p> <p>M(G&M)–4–7 Measures and uses units of measures appropriately and consistently, and makes conversions within systems when solving problems across the content strands. (State)</p> <p>M(DSP)–4–2 Analyzes patterns, trends, or distributions in data in a variety of contexts by determining or using measures of central tendency (median or mode), or range. (State)</p>	
<p>Assessment/Evaluation</p> <p>Students will accurately measures their heights and record to the nearest $\frac{1}{2}$ inch.</p> <p>Students will orally explain their strategy for how they found the “average” height of the class.</p> <p>Students will use the algorithm to find the arithmetic mean of the class.</p>	
<p>BEFORE – Introduce –</p> <p>Introduce Statistics / Data Analysis.</p> <ul style="list-style-type: none"> I will begin by asking the students what they know about statistics. “Statistics is the study of data. Data gives us information about something in the real world. We can collect data right now. How many people in the room are left handed? (Students will raise hands, and I will say “our data shows that ___ students in this class are left handed.”) How many students brought lunch to school today? (Students will raise hands, and I will say “our data shows that ___ students in this class brought lunch to school today.”) People collect data by counting as we did, or by measuring or doing experiments. Who can think of some data we can collect by measuring?” Now ___ brought lunch today, and let’s say that ___ brought lunch tomorrow, and ___ brought lunch on Friday. The average number of students who brought lunch is _____. What 	

does that mean to you?

- “Now after we have collected data, we need to study it. We have to look for patterns—to analyze the data. We will use data to find out information about ourselves or the world around us.”

Introduction to Measuring / Predictions

- “You will be measuring yourselves so we can find out what the average height is in the classroom.”
- “Does anyone have any predictions about the average height?
The students will make predictions, and explain why they made that particular prediction. I will write the predictions on paper.
- “Now when you measure, we are going to measure in inches to the nearest half inch.”
“How many inches are there in a foot?” (A student will respond, and answer 12 inches.)
“Now if my little sister is 3 feet 2 inches, how tall would she be in inches? (Answer: 38 inches.)
“We are using inches to measure so that way it will be easier to graph.”

Directions

- “You will measure those in your group, and record the information down. Then you will find a way to determine how tall the ‘average’ or ‘typical’ person in your group is.”

DURING - Explore

Measuring Selves

- Students will be working in groups based on where they are seated.
The students will receive measuring tape, and measure the students in their group to the nearest half inch.
The students will record this on a recording sheet.
Together, we will make a line plot of the classes’ data to be used later.

Finding the Average

- The students will find the average in their group. They may look at the mode, the median, or another way to represent the average.
- After five minutes of trying to figure out the average we will discuss what the students have done.
I will define what they have found. (The mode, median, range, average, etc.)
I will define the arithmetic mean – The average of a number of different amounts. The total of all scores divided by how many scores there are.
I will demonstrate how to find the mean using sample numbers.
- The students will find the mean in their group.
- After the students have found their mean, we will discuss how we can find the average for the whole class.
I will show the line plot we made. (A student may suggest making another line plot with only the means of each group.)
To find the average of the entire class we will take an average of each group. If there are 5 groups, we will average each of the groups up, and divide by 5.

AFTER/CLOSE - Share**Survey vs. Population**

- We will look at our predictions and see how they compare to the resulting mean.
- We will discuss why each group got different numbers, and how some of the groups were not representative of the class.
What caused these differences? Possibly an outlier in the class, or all of the tall students sitting together.

Measures of Central Tendency

- If it has not already been discussed, we will review the median and mode of the data. And we will discuss how the outlier affects the mean, but does it affect the median? Was the mode representative of the typical or average student? Was there actually an “average” student in the classroom? Was any student the same in length as the mean?

Additional Plans**Students who may need extra help**

I will be walking around to work with the students. If having trouble measuring, the students can stand next to the board and mark the heights, and then measure the board. Students can use a calculator if finding the mean becomes difficult.

Extension

The students can hypothesize another way to represent the data. (A table, a chart, another type of graph.) If there is time, the students can make this type of representation.

I will provide a worksheet with word problems for students to practice finding the mean.

Recording Sheet for Group # ____

Student	Height in Inches to the Nearest $\frac{1}{2}$ inch

Now determine the average height in your group.

Name: _____

Date: _____

Directions: Answer the following problems using the arithmetic mean.

To find the mean, add all of the amounts/scores together, and divide by the total number of scores.

Example:

Scores on Spelling Quizzes:

13	15	16	16	18	20
----	----	----	----	----	----

$$13 + 15 + 16 + 16 + 18 + 20 = 88$$

$$88 \text{ divided by } 6 = 14 \text{ remainder } 4$$

$$6 \overline{)88} = 14 \text{ R } 4$$

1. On Monday you received \$1.00 for allowance, on Wednesday you received \$1.50 for allowance, and on Friday you received \$3.50 for allowance. What is your **total** allowance for the three days? *AND* What is your **average** allowance for the three days?

2. These are the hours you slept over the past week.

Monday	Tuesday	Wednesday	Thursday	Friday
8 hours	9 hours	8.5 hours	8.5 hours	6 hours

What is the **average** number of hours you slept?

3. What is the **arithmetic mean** of these following shoe sizes?

8	4	6	7	12	13	4	6
---	---	---	---	----	----	---	---

What is the **median** (middle number)?What is the **mode** (number that appears the most)?What is the **range** (difference between the largest and smallest number)?

Appendix D: Lesson 2 and Materials

Name Kayla Botelho
Date Tuesday, May 25, 2010

Lesson # 2
Grade Level 4

<p>Teacher materials</p> <p>4th grade line plot Mystery data</p>	<p>Student materials</p> <p>Calculators (passed out before lesson)</p> <p>Mystery Data Pencils, Paper</p> <p>Extension Line Plot (can be used for homework)</p>
<p>Objectives/outcomes</p> <p>To compare two sets of data. To make a graphical representation of a data set. To find the arithmetic mean.</p> <p>M(DSP)–4–2 Analyzes patterns, trends, or distributions in data in a variety of contexts by determining or using measures of central tendency (median or mode), or range. (State)</p> <p>M(DSP)–4–3 Organizes and displays data using tables, <u>line plots</u>, bar graphs, and <u>pictographs</u> to answer questions related to the data, to analyze the data to formulate or justify conclusions, to make predictions, or to solve problems. (Local)</p> <p>M(DSP)–4–6 In response to a teacher or student generated question or hypothesis, groups decide the most effective method (e.g., survey, observation, experimentation) to collect the data (numerical or categorical) necessary to answer the question; collects, organizes, and appropriately displays the data; analyzes the data to draw conclusions about the question or hypothesis being tested, and when appropriate makes predictions; and <u>asks new questions and makes connections to real world situations.</u> (Local)</p>	
<p>Assessment/Evaluation</p> <p>Students will use the fourth grade class data to determine which grade the mystery data comes from. Students will use the mystery data to make a line plot with the students' heights. Students will accurately use the algorithm to find the arithmetic mean of the mystery class.</p>	
<p>BEFORE – Introduce –</p> <p>Homework</p> <ul style="list-style-type: none"> We will go over the homework, and answer each of the 3 questions. I will write all work on the worksheet and use the document camera. <p>Review of Measures of Central Tendency</p> <ul style="list-style-type: none"> We will look at the line plot we created yesterday, and I will remind the students of the mean (54.95 rounded to 55), median (54.5), and mode (54). I will ask the students if they would expect these values to be about the same. If so why? 	

(Because they are all types of averages that will represent the typical student.)

Mystery Data

- “So yesterday, we found the average height of our class by using the mean. We took the average of each group, and then averaged those numbers together. What we could have done was added up all 19 heights, and divided it by 19. “
- “Today we have data from another class in the school, and it is your job to determine which grade it came from.”
- “How do you think you can determine which grade the data came from?” (The students will offer possible suggestions, and I will have them stay away from merely guessing.)
“So we will need to compare our data of fourth graders to determine which grade the mystery data is from. Take a moment to hypothesize what you think we can do.”
- The students will share their suggestions on how to compare the two classes.

DURING - Explore

Finding the Average

- Using the data from the chart, the students will make a line plot that they can use to visually compare the classes. The students will have the necessary supplies at their desks. (Graph paper, pencils)
- The students will work in their group to find the mean of the first grade. They will determine if they are going to add all of the students together and divide by the total, or if they are going to break it up into groups.
- Once the students have the mean, they will collectively decide which grade it came from.

AFTER/CLOSE - Share

Share Time

- The students in each group will share their predictions, and explain why they think it is that particular grade. (This is not a competition, so the students will feel free to share their thoughts and predictions.)
- The students will share their line plots, and we will discuss how they have used the line plot to help them determine which grade this information was from.
- Together we will determine the median and mode for the mystery data.
- I will share with the class what grade level the data was from. We can discuss how close or far the students were in their predictions.
- Now what about if the data was from fifth grade? How would it compare to our data? (It would be slightly larger.) What about ninth grade? (Their average height would be considerably larger.)

If there is extra time, we can discuss what else the average can tell us about the data.

We can continue any unfinished discussions from the first lesson, including how outliers affect the data.

Additional Plans

Students who may need extra help

Students can randomly select half of the students and work with half of the data to make the line plot, and find the mean.

Extension / Homework

Students can find the median, mode, range, outliers in the mystery data.

Students can look at a line plot or data set of another class, and determine which grade it is from.

Directions:

As a group,

- Use the mystery data to make a line plot for this mystery class.
 - Find the mean of the data set.
 - Determine which grade the data comes from. Explain why!
-

Done early?

Find the following with the members of your group:

- What is the median of this data?
- What is the mode?
- What is the range?
- Is there an outlier in this data set?

Mystery Data

This is data that comes from another class. Determine which grade this data comes from.

39	45	46	46
47	47	48	48.5
48.5	49	49	49.5
50	50	50	50.5
52	52	52	52.5
53	54.5		

Name: _____ Date: _____

More Mystery Data

Using the arithmetic mean, the average height in our class is 55 inches. The median is 54.5 inches, and the mode is 54 inches.

Using our class data on height, determine which grade the following data is from.

To find the arithmetic mean: Add all of the amounts together, and divide by the total number of pieces of data.

Height in Inches			
53	53.5	54	54.5
55	55	58.5	59
60	60	60	60.5
61	61.5	62	64
65	65.5	66	72

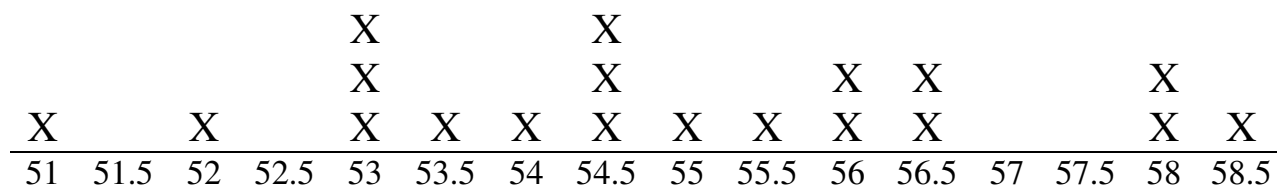
The mean of this data is: _____

The median of this data is: _____

The mode of this data is: _____

I think this data is from _____ grade, because: _____

Heights of a Mystery Class



Use our class data and this line plot to determine which grade this data came from.

The mode of this data is: _____

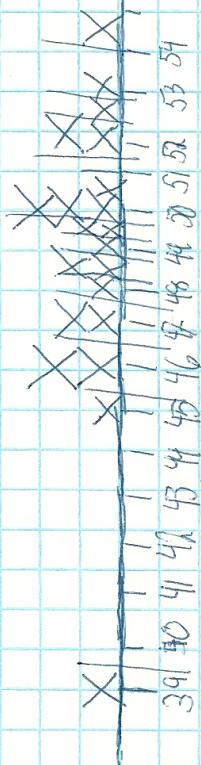
The median of this data is: _____

The mean of this data is: _____

This data comes from _____ grade, because: _____

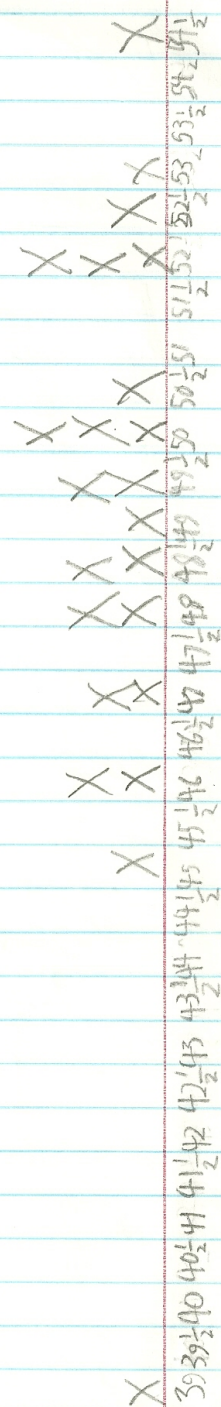
Appendix E: Lesson 2 Student Work Samples

Group 1

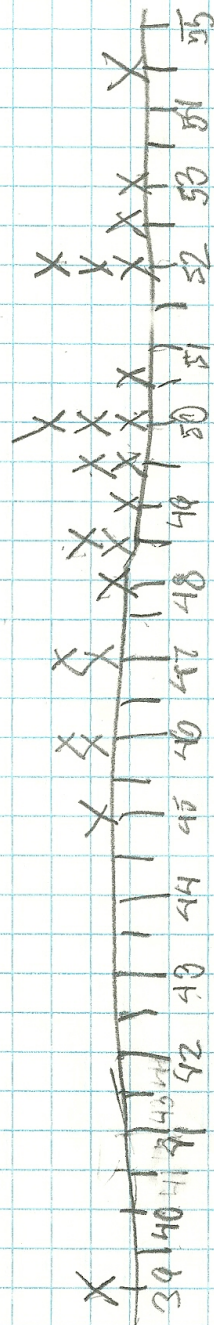


Group 2

Mystery grade heights



Group 3 Rough Draft

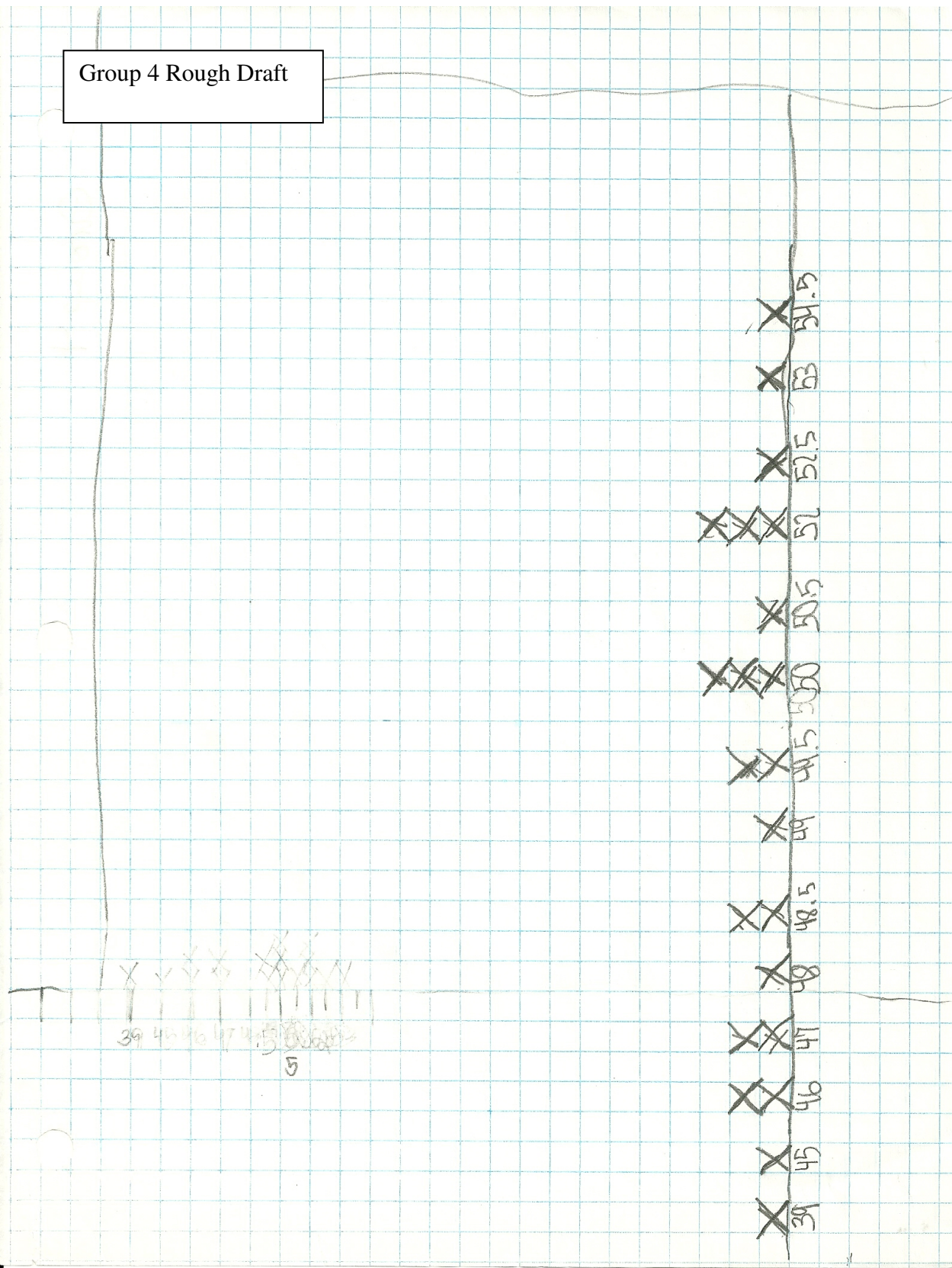


mean 49

Group 3

X	39	✓
	40	
	41	
	42	
	43	
	44	
	45	✓
X	46	✓
X	47	✓
	48	✓
X	49	✓
X	50	✓
X	51	✓
X	52	✓
X	53	✓
X	54	✓
X	55	✓

Group 4 Rough Draft



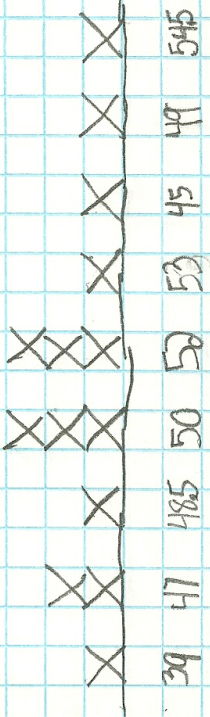
Group 4

Mystery Data

X	39
	40
	41
	42
	43
	44
X	45
X	46
X	47
	48
X	49
X	50
X	51
X	52
X	53
X	54
X	55

Rough draft

Group 5 Rough Draft



Appendix F: Lesson 3 and Materials

Name Kayla Botelho
Date Wednesday, May 26, 2010

Lesson # 3
Grade Level 4

<p>Teacher materials</p> <p>4th grade line plot</p>	<p>Student materials</p> <p>Measuring Devices Recording Sheets</p> <p>Sheet to record averages</p> <p>Calculators Pencils, Paper</p> <p>Chart Paper for Line Plots</p>
<p>Objectives/outcomes</p> <p>To make a graphical representation of a data set. To find the arithmetic mean. To describe what they have found.</p> <p>M(DSP)–4–2 Analyzes patterns, trends, or distributions in data in a variety of contexts by determining or using measures of central tendency (median or mode), or range. (State)</p> <p>M(DSP)–4–3 Organizes and displays data using tables, <u>line plots</u>, bar graphs, and <u>pictographs</u> to answer questions related to the data, to analyze the data to formulate or justify conclusions, to make predictions, or to solve problems. (Local)</p> <p>M(DSP)–4–6 In response to a teacher or student generated question or hypothesis, groups decide the most effective method (e.g., survey, observation, experimentation) to collect the data (numerical or categorical) necessary to answer the question; collects, organizes, and appropriately displays the data; analyzes the data to draw conclusions about the question or hypothesis being tested, and when appropriate makes predictions; and <u>asks new questions and makes connections to real world situations.</u> (Local)</p>	
<p>Assessment/Evaluation</p> <p>Students will use their collected measurements to make a line plot of the data. Students will use this data to accurately calculate the mean, median, and mode. Students will make statements about the data and compare it to what they expected.</p>	
<p>BEFORE – Introduce –</p> <p>Measuring</p> <ul style="list-style-type: none"> The students will be going into different grades to measure the heights of those students. I will describe to the students how the measurements should be done. Children will leave their shoes on, stand tall against the wall with the measuring device. One of the fourth grade students will make sure the student is standing tall, another will look at the measurement and say it orally, and another student will record this data on a recording sheet. If there is a fourth 	

student, they will check for accuracy of the measurement.

Directions

- Once the measurements are taken, the students will make a prediction about the average student in that class. They will write this prediction down, and will refer to it later.
- “First you will make a line plot, collectively. Be sure to include a title, label the x-axis--this horizontal line, and the spacing is important. It should be in $\frac{1}{2}$ inch increments. Therefore if your first piece of data is 40 inches, and your next piece of data is 41.5 inches. You must put a space for the 40.5 inches and 41 inches. If not the graph would not be accurate, and we could not see any outliers.”
- “Then each of you will find the mean, median, and mode of the data. You will compare your answers together, and be certain they are all the same. Calculators are on the back table. Determine if there is an outlier. If so does it affect the mean, median or mode?”
- “Lastly you will compare the average you found, to the average you predicted. Were they the same, or different? Why do you think so?”
- “Now one student from each group, please gather the materials at the back table, and you can get started.”

DURING - Explore

Line Plot

- Together, the students will make a large line plot (on chart paper) to showcase their data. This line plot will have a title, the x-axis will be labeled, and the spacing on the plot should be in $\frac{1}{2}$ inch increments.

Finding the Averages

- The students will individually find the mean, median and mode for the data. This will be a way to ensure that all of the students are doing the work. The students will compare their answers for accuracy. The students will identify if there is an outlier in the data.
- Once the calculations are done, the students will compare their predictions to the actual averages. The students will discuss how they were similar or different, and why they think so. The students will also discuss is what you expect for this particular grade.

AFTER/CLOSE - Share

Share Time

- The students will present their line plot, and their findings to the class. The students will share if anything shocked them during this activity.
- Together, we will compare the data in each of the 5 grades. Possible things to look at :
 - What do you see/notice?
 - The difference between the means in the grades. Each year do the students gain so many inches, or was there a year in which there is lots of growth or no growth?
 - Did any of the grades have the same data? Why do you think this is so?
 - How do the two fourth grades compare? Is what we see, what we expected?

Additional Talking Ideas

- Greer said yesterday that she was the average height of a third grader. If Greer is ____ inches, how does she compare to the average third grader?
- Our mystery data showed us that the average first grader was 49 inches. How does this

compare to our 1st grade class at Henry Barnard School?

- Did anyone have an outlier that affected the mean? Made it considerably larger/smaller than the median to a point where it does not accurately describe the “typical” student. (If we take it out, the mean would be different, and more representative.)

Additional Plans

Students who may need extra help

Students can work in pairs to calculate the mean, median, and mode. Students can make individual line plots, if necessary.

If applicable, a student can work with half of the students. (Calculate only the even students from ____ grade, instead of all.)

Extension / Homework

Students can find another way to represent the data. (Bar graph, stem and leaf plot)

If the extension from last class was not used, the students can complete it.

Predictions

We predict the average _____ grader will be _____ inches tall,

because: _____

_____.

Stop. Create a line plot; calculate the mean, median, and mode. Identify any outliers.

AFTER:

- Compare the mean, median, and mode to your prediction.
 - Was it similar?
 - Was it different?
 - Why do you think so?
- Was there anything that surprised or shocked you?
- Was there anything you expected?
- If there was an outlier, did it affect your mean? Explain why.

Data for _____ Grade

Record the heights of the students below.

Student	Height to the Nearest $\frac{1}{2}$ Inch
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	
25.	

Name: _____ Date: _____

Data for _____ Grade

- The mean is:
- The median is:
- The mode is:
- Identify any outliers:

Appendix G: Lesson 3 Student Work Samples

